Patent

IN THE UNITED STATES
PATENT AND TRADEMARK OFFICE

Applicant:	Brady et al.
Docket No.:	FE-00439
Serial No.:	09/590,805
Filing Date:	June 9, 2000
For:	Increasing the Susceptibility of an Integrated Circuit to Ionizing Radiation
Art Unit:	2811
Examiner:	Ori Nadav

September 23, 2002

Assistant Commissioner for Patents
Washington, D.C. 20231

S I R:

APPELLANT'S BRIEF IN SUPPORT OF:
AN APPEAL FROM THE DECISION OF THE EXAMINER
TO THE BOARD OF PATENT APPEALS
UNDER 37 CFR §1.191

(1) *Real Party in Interest*

Application 09/590,805, which is the subject of this Appeal, is assigned to BAE Systems.

(2) *Related Appeals and Interferences*

There are no other appeals or interferences that will directly affect, be directly affected by or otherwise have a bearing on the Board's decision in this Appeal.

(3) *Status of Claims*

Application 09/590,805 was filed with 21 claims. Claims 8-21 were cancelled and claims 22-25 were added by an Amendment that was filed January 17, 2002. Claims 1-7 and 22-25 are pending and have been finally rejected by the Examiner. Applicants are appealing the rejection of claims 1-7 and 22-25.

(4) *Status of Amendments*

No Amendment has been filed since the issuance of an Official Action that was mailed on April 9, 2002 in which the claims now on appeal were finally rejected.

(5) *Summary of the Invention*

Some embodiments of the claimed invention provide integrated circuits that have <u>increased susceptibility</u> to ionizing radiation.

Most state-of-the-art processing technologies produce integrated circuits — more particularly transistors — that are inherently highly tolerant to damage from ionizing radiation. (Ionizing radiation is high-energy radiation that is capable of producing ionization in substances through which it passes. Ionizing radiation includes highly-energetic charged particles such as alpha and beta rays, and non-particulate radiation such as x-rays and neutrons.)

The relatively high-radiation tolerance of state-of-the-art integrated circuits is of no benefit to most users and for most applications. But this high-radiation tolerance makes these circuits suitable for use in aerospace and military applications. There is a concomitant risk, therefore, that these circuits could be used militarily against the United States or its allies. As such, Department of Justice export restrictions (ITAR) might prevent those chips from being freely sold or exported. To the extent that a commercial chip fabricator is restricted by ITAR from freely selling or exporting chips that have a

legitimate non-military use, it suffers financially. (Specification, p. 3, line 30 through p. 4, line 14.)

Some embodiments of the claimed invention provide integrated circuits that have increased susceptibility to ionizing radiation, while at the same time retaining the advantages of contemporary processing technologies (*e.g.*, small feature size, *etc.*). These integrated circuits can therefore be freely sold and exported without creating the justifiable fear that they can be used militarily against the United States or its allies.

In accordance with the illustrative embodiment of the present invention, an integrated circuit is designed and fabricated with contemporary processing technologies, except that certain devices, referred to in the specification as "safeguard devices," are electrically coupled to the "utile devices" in the integrated circuit. The term "device," as used in the applicants' specification, means a transistor and the surrounding materials that affect its operating parameters. (P. 7, line 29 through p. 8, line 2.)

A utile device (301-*i*) is a device that processes an information-bearing signal and provides the functionality for which the integrated circuit was designed, fabricated and utilized. Simply put, a utile device is a standard, contemporary transistor.

A safeguard device (302- *i*) is a transistor that is fabricated so that it is more susceptible to ionizing radiation than transistors, such as utile devices, that are fabricated by standard, contemporary processing technologies. In particular, when safeguard devices are exposed to ionizing radiation, the "parasitic transistor" (of the safeguard device) turns on before the "operating transistor" (of the safeguard device), effectively shorting the source to the drain regardless of the state of the operating transistor. (A parasitic transistor is an *unintended* but real transistor structure intended that results from artifacts in the manufacture of a CMOS or NMOS operating transistor. *See*, p. 1, line 14 through p. 3, line 29 and FIGs. 1A-1C for background as to the physical and electrical structure of *n*-type transistors and radiation susceptibility and p. 11, lines 3-24 for a fabrication method.)

The safeguard devices (320-*i*) are coupled to the utile devices of the integrated circuit in such a manner that when the integrated circuit is bombarded with ionizing radiation, the safeguard devices irreparably destroy (at least in some embodiments) the functionality of the integrated circuit.

In general, the safeguard device can destroy the functionality of an integrated circuit in two ways. First, one or more safeguard devices can interfere with the logical operation of an integrated circuit, by, for example, shorting a signal lead to ground (*i.e.*, when the parasitic transistor structure begins to "prematurely" conduct due to exposure to ionizing radiation). Second, one or more safeguard devices can interfere with the electrical operation of an integrated circuit by, for example, shorting power V_{DD} (*i.e.*, power) to ground. (*See*, FIGs. 3 and 4 and the accompanying description at p. 8, line 19 through p. 10, line 3.)

The safeguard devices on the integrated circuit do not, in general, provide any functionality to the end-user and exist only to completely or partially destroy the functionality of the integrated circuit when the integrated circuit is exposed to ionizing radiation.

(6) *The Issues for Review*

The issues for review are as follows.

(a) Whether the drawings are properly objected to under 37 CFR § 1.83(a).

(b) Whether claims 1-2, 4-7 and 22-25 were properly rejected under 35 USC § 103(a) over U.S. Pat. No. 5,589,708 to Kalnitsky in view of admitted prior art ("APA").

(c) Whether claims 1-2, 4-7 and 22-25 were properly rejected under 35 USC § 103(a) over U.S. Pat. No. 5,748,412 to Murdock et al. in view of APA.

(d) Whether claim 3 was properly rejected under 35 USC § 103(a) over Kalnitsky and APA as applied to claim 1, and further in view of U.S. Pat. No. 5,294,843 to Tursky et al.

(e) Whether claim 3 was properly rejected under 35 USC § 103(a) over Murdock et al. and APA as applied to claim 1, and further in view of Tursky et al.

(7) *Grouping of Claims*

The appealed claims do not stand or fall together. Rather, those claims are segregated into six groups as follows.

Group 1: Claims 1 and 2 stand or fall together.

Group 2: Claim 3.

Group 3: Claims 4 and 5 stand or fall together.

Group 4: Claims 6 and 7 stand or fall together.

Group 5: Claims 22 and 25 stand or fall together.

Group 6: Claims 23 and 24 stand or fall together.

(8) *Argument*

Issue 6(a): Whether the Drawings are Properly Objected to Under 37 CFR § 1.83(a)

The Examiner objected to the Drawings alleging that they fail to show "a first device comprising a field oxide region including a material that traps positive charge and a second device [that has] not been implanted with that material." In support of the objection, the Examiner cited MPEP §608.02 for the proposition that "any structural detail that is essential for a proper understanding of the disclosed invention should be shown in the drawing."

The objection presumably arises from the language of claim 3, which recites that:

> said first device comprises a field oxide that has been implanted with a material that traps positive charge when said first device is exposed to ionizing radiation and said second device has not been implanted with said material.

The claimed invention pertains to incorporating dose-soft (*i.e.*, radiation intolerant) devices (*i.e.*, transistors) into an integrated circuit to sabotage the operation of a circuit. The case is not about creating dose soft devices — that's known — it's about <u>using</u> them.

What is essential in this case is depicted in FIGs. 3 and 4, which depict the electrical connection between safeguard devices and utile devices to create a circuit having increased susceptibility to ionizing radiation. The Examiner would have applicants provide another Figure that shows one device with "damage centers that trap positive charges" connected to another device that doesn't have such damage centers. That Figure would not add anything of merit or value to this application or otherwise aid one skilled in the art in understanding this invention. It is notable that the omission of such a Figure is consistent with the language of 37 CFR 1.83(a), which requires that:

> (a) The drawing in a nonprovisional application must show every feature of the invention specified in the claims. *However, conventional features disclosed in the description and claims, where their detailed illustration is not essential for a proper understanding of the invention, should be illustrated in the drawing in the form of a graphical drawing symbol or a labeled representation* (e.g., a labeled rectangular box). (Emphasis added.)

Those skilled in the art know how to make dose-soft devices. To use the language of 37 CFR 1.83(a), they are "conventional features ... where their detailed illustration is not essential for a proper understanding of the invention." Consequently, they "should be illustrated in the drawing in the form of a ... labeled representation." This is exactly what the applicants have done in FIGs. 3 and 4.

Notwithstanding the familiarity of those skilled in the art with the phenomena of radiation susceptibility and "charge-trapping," the applicants did go to some length to relate the physical and electrical structure of the transistor to these phenomena by way of FIGs. 1A through 1C and the accompanying discussion at p. 1, line 27 through p. 3, line 29. It is urged that the Figures that appear in the application provide all that is essential for a proper understanding of the claimed invention.

ART REJECTIONS [Issues 6(b) through 6(e)]

The References Relied Upon by the Examiner

The prior art relied upon by the Examiner is described below and contrasted with applicants' invention. Admittedly, the distinctions highlighted by the applicants pertain, in some cases, to features that are not recited in all of the claims on appeal. But there were no Section 102 rejections, and the distinctions raised by the applicants are relevant to the issue of the obviousness.

After the prior art is discussed, the Examiner's art rejections, as identified at items 6(b) through 6(e) above, are scrutinized with a focus on the language of applicant's claims.

1. U.S. Pat. No. 5,589,708 to Kalnitsky

Kalnitsky discloses that a "dosimeter" can be created within an integrated circuit. The dosimeter is created by forming radiation-hard transistors as well as standard transistors in the same integrated circuit. Kalnitsky forms the two types of transistors by selectively doping different portions of a circuit. (Col. 2, line 56 through col. 3, line 18.)

According to Kalnitsky, the radiation-hard transistors and standard transistors will degrade or recover from exposure to ionizing radiation at different rates. Kalnitsky proposes locating a sensor on the chip that senses differences between the performance of the two types of transistors, thereby sensing the accumulated radiation dose. (Col. 3, lines 38-42.) Kalnitsky also proposes incorporating a "self-adapting" circuit that responds to the sensor, which could be used to compensate for any loss in performance due to the ionizing radiation. (Col. 3, lines 42-48.)

There are a number of significant differences between the case on appeal and Kalnitsky. In particular:

- While applicant modifies fabrication procedures to produce dose-*soft* (reduced radiation resistance) circuit elements, Kalnitsky modifies procedures to produce dose-*hard* (enhanced radiation resistance) transistors.
- While applicant produces dose-soft circuit elements to sabotage and, in some case, irreparably damage the operation of an integrated circuit on exposure to ionizing radiation, Kalnitsky produces dose-hard circuit elements toward the end of keeping an integrated circuit properly functioning (*i.e.*, by including a sensor and a self-adapting circuit to compensate for performance losses).
- For applicants' invention to work, dose-soft transistors (*i.e.*, safeguard devices) are electrically coupled to standard transistors (*i.e.*, utile devices). In Kalnitsky's invention, the dose-hard transistors and standard transistors are electrically isolated from one another so that performance differences can be evaluated.

Fairly read, Kalnitsky teaches away from the claimed invention. Although perhaps over-used as an argument for rebutting an obvious rejection, it seems apropos in this case.

2. Admitted Prior Art ("APA")

FIG. 3 of the case on appeal depicts two transistors (*i.e.*, utile devices) electrically connected to one another. Both the transistors have one lead connected to power (*i.e.*, V_{DD}), one lead connected to ground.

3. U.S. Pat. No. 5,294,843 to Tursky et al.

Tursky et al. discloses a "freewheeling diode circuit." A freewheeling diode circuit is a rectifier diode connected across an inductive load to carry a current resulting from the energy stored in the inductance when no power is being supplied by the source to the load.

According to Tursky et al., the freewheeling diode circuit includes a first diode (12) with a "soft" recovery behavior and a second diode (14) with a "snappy" recovery behavior. The second diode is connected in parallel to the first diode. (Col. 6, lines 4-10.)

According to Tursky et al., the soft recovery behavior pertains to the emptying of a plasma of charge carriers from the semiconductor body during switching from the conducting phase into the blocking phase. For a diode exhibiting a soft recovery behavior, the reverse current decays slowly. Since the induced surge voltage corresponds to this decay behavior, only a small voltage is generated by a soft switching diode. This is in contrast to a diode with a hard or snappy switching behavior, wherein high voltages are induced. (Col. 1, lines 11-37.)

The term "soft," as in "soft diode," has nothing whatsoever to do with resistance to ionizing radiation (*i.e.*, as in "radiation soft," *etc.*) It refers to the soft recovery behavior described above. The terms "soft" and "snappy" are described in further detail at col. 6, line 56 through col. 8, line 6.

Tursky et al. disclose that a snappy diode can be produced by an epitaxial diode with gold diffusion. Furthermore, Tursky et al. disclose that a soft diode can be produced by irradiation with protons at an energy of 2.25 MeV with an irradiation strength of 5×10^{12} particles per square centimeter, wherein the suitable range for the energy applied is 1.5 and 3 MeV and the particle density is from about 10^{12} to 2×10^{13} per square centimeter. By contrast, the applicants' disclose that to create a dose-soft transistor, oxygen or another species that does not generate electrons, is accelerated at low energy (about 5 KeV) and at a relatively high dose (1×10^{14} to about 1×10^{16} particles per square centimeter) into the base layer of the nascent transistor. (Page 11, lines 12-17.)

Tursky et al. is unrelated to the subject matter of the case on appeal.

4. U.S. Pat. No. 5,748,412 to Murdock et al.

Murdock et al. discloses a method and apparatus for protecting magnetoresistive sensor elements from electrostatic discharge. (Col. 2, lines 28-30.)

The Murdock et al. apparatus includes "reader" conductors (18a and 18b) that are disposed between a magnetoresistive sensor (34) and detection circuitry (16). A diode assembly (30) interconnects the reader conductors.

The diode assembly incorporates "soft" diodes that conduct at a voltage that is less than the operating voltage of the magnetoresistive sensor. Furthermore, the diode assembly has a

resistance that prevents electrical conduction across the diode assembly between the reader conductors when the voltage between the reader conductors is less than or equal to an operating voltage of the magnetoresistive sensor.

When the voltage between the reader conductors is greater than a pre-selected protection voltage threshold (based on the sensivity of the magnetoresistive sensor to electrostatic discharge), the diode assembly shunts current across the diode assembly between the reader conductors thereby "short circuiting" the reader conductors to protect the magnetorestrictive sensor. (Col. 5, lines 44-62.) In other words, the diode assembly, rather than the magnetoresistive sensor, will carry the current during such an electrostatic discharge.

There are a number of significant difference between Murdock et al. and the case on appeal. Specifically:

- Applicants' invention pertains to ionizing radiation, while Murdock pertains to electrostatic discharge. Ionizing radiation is high-energy radiation that is capable of producing ionization in substances through which it passes. Ionizing radiation includes highly-energetic charged particles such as alpha and beta rays, and non-particulate radiation such as x-rays and neutrons. Electrostatic discharge is a transient movement of charges that were at rest.
- Applicants' invention pertains to transistors and their incorporation into an integrated circuit, while Murdock et al. pertains to diodes that are used to protect a magnetoresistive sensor in a magnetoresistive head assembly. The applicants' definition of the word "device" as a transistor and surrounding material cannot be ignored.
- In applicants' invention, the safeguard devices need to be exposed to some level of ionizing radiation to conduct at a lower than normal voltage. The safeguard devices (*e.g.*, radiation-soft transistors) behave normally until so exposed. In Murdock et al., the "soft" diodes do not need to be exposed to ionizing radiation, or any causative agent, to conduct at a "low" voltage. They are fabricated to conduct at a certain voltage that is lower than the operating voltage of the magnetoresistive sensor.
- Applicant discloses, at least in some embodiments, *destroying* a circuit when exposed to an undesirable condition (*i.e.*, a certain level of ionizing radiation). Murdock et al., like Kalnitsky, discloses *protecting* a circuit (*i.e.*, the magnetoresistive sensor) when exposed to an undesirable condition (*i.e.*, high voltage).

Murdock et al. appears to be completely unrelated to the case on appeal.

As is perhaps already becoming clear, in rejecting the claims on appeal, the Examiner has ignored the meaning of terms (*e.g.*, device, safeguard device, *etc.*) that were explicitly defined in applicants' specification, has ignored the meaning of terms from the prior art (*e.g.*, soft diodes, *etc.*) and used them out of context, and makes unsupported statements concerning the prior art.

Issue 6(b): Whether claims 1-2, 4-7 and 22-25 were properly rejected under 35 USC § 103(a) over U.S. Pat. No. 5,589,708 to Kalnitsky in view of admitted prior art ("APA")

<u>As to Group 1: Claims 1 and 2</u>

Claim 1 on appeal recites an integrated circuit comprising:

> a first device comprising a first lead, a second lead, and a third lead, wherein said third lead of said first device is electrically connected to ground; and
>
> a second device comprising a first lead, a second lead, and a third lead, wherein said third lead of said second device is electrically connected to ground, and wherein said first lead of said second device is electrically connected to said first lead of said first device;
>
> wherein the effective threshold voltage of said first device is more susceptible to be lowered by ionizing radiation than is the effective threshold voltage of said second device.

Kalnitsky does not disclose the claimed limitation that two devices having different radiation susceptibility (*i.e.*, two different types of transistors, *etc.*) are electrically connected to one another. But the Examiner argues that because the APA (*e.g.*, FIG. 2) teaches electrically connecting two standard transistors to one another, it would obvious for one skilled in the art to connect the radiation-hard and standard transistors of Kalnitsky to one another.

There is no support for this assertion. What's the motivation for the combination? The problem faced by the applicants' was how to address the issue of the inherent radiation hardness of contemporary integrated circuits. What motivation is there to combine the APA (*i.e.*, two transistors connected to one another) with Kalnitsky (*i.e.*, a radiation hard transistor and a

standard transistor, a sensor to monitor performance differences, and a self-adapting circuit to compensate for any detected performance losses)?

It is noteworthy that if, in Kalnitsky, a dose-hard transistor were connected to a standard transistor, then the difference in performance of the transistors, on exposure to ionizing radiation, could not be detected. There is no motivation to combine Kalnitsky and the APA as the Examiner suggests.

And, as such, claim 1, and claim 2 dependent thereon, are allowable over the combination of Kalntisky and the APA.

<u>As to Group 3: Claims 4 and 5</u>

Claim 4 recites that the integrated circuit of claim 1 comprises:

> a microprocessor that comprises a control sequencer coupled to an arithmetic logic unit.

Claim 5 recites that the integrated circuit of claim 1 comprises:

> an arrangement of memory cells operatively connected to an address decoder.

There is no disclosure or suggestion in Kalnitsky or the APA to incorporate either a control sequencer coupled to an arithmetic logic unit, or an arrangement of memory cells operatively connected to an address decoder into an integrated circuit that includes transistors having different radiation sensitivity. Claims 4 and 5 are allowable over Kalnitsky and the APA on this basis.

<u>As to Group 4: Claims 6 and 7</u>

Claim 6 recites that in the integrated circuit of claim 1:

> said second lead of said first device is connected to ground,
> said first lead of said first device is connected to power, and
> said first lead of said second device is connected to power.

Claim 7 recites that in the integrated circuit of claim 1:

> said first device shorts power to ground when said device has been exposed to ionizing radiation.

Claims 6 and 7 describe the nature of the connection between the first device (*e.g.*, the safeguard device) and the second device (*e.g.*, the utile device). More particularly, the

devices are connected so that the first device shorts power to ground when the first device has been exposed to ionizing radiation.

Neither Kalnitsky, the APA, nor the combination thereof discloses or suggests that two devices having different radiation susceptibility should be connected in the claimed manner. Claims 6 and 7 are allowable over the combination of Kalnitsky and the APA on this basis.

As to Group 5: Claims 22 and 25

Claim 22 recites an integrated circuit comprising:

> a safeguard device comprising a first lead, a second lead, and a third lead, wherein said third lead of said first device is electrically connected to ground; and
> a utile device comprising a first lead, a second lead, and a third lead, wherein said third lead of said second device is electrically connected to ground, and wherein said first lead of said second device is electrically connected to said first lead of said first device;
> wherein upon exposure to a sufficient amount of ionizing radiation, said safeguard device turns on before said utile device, and affects operation of said utile device.

Claim 22 recites a "safeguard device" and a "utile device." These terms, as well as the term "device," are <u>defined</u> in applicants' specification. In particular, as described in the specification at p. 8, lines 3-8:

> For the purposes of this specification, a "utile device" is defined as a device that processes an information-bearing signal. Utile devices can be operate in either analog mode or digital mode or both. Typically, the utile devices on an integrated circuit provide the functionality for which the circuit was designed and fabricated and utilized.

And it is stated at p. 8, line 29 through p. 9, line 4 that:

> For the purposes of this specification, a "safeguard device" is defined as a device that is designed to interrupt the functioning of all or part of an integrated circuit when the integrated circuit is exposed to ionizing radiation. In general, the safeguard devices on the integrated circuit do not provide any functionality to the end-user and only exist so that they can completely or partially destroy the functionality of the integrated circuit when the integrated circuit is exposed to ionizing radiation.

When interpreting the claims, these terms must be accorded the definition provided in the specification. *See* MPEP §2111.01. Kalnitsky does not disclose or suggest incorporating, into an integrated circuit, a safeguard device "that is designed to interrupt the functioning of all or part of an integrated circuit when the integrated circuit is exposed to ionizing radiation." In fact, as previously indicated, Kalnitsky teaches away from this. Specifically, Kalnitsky includes devices for maintaining circuit operation when the circuit is exposed to radiation. There is nothing about the combination of Kalnitsky and the APA that would lead one skilled in the art to the invention defined by claim 22. Claim 22 is allowable over the combination of Kalnitsky and the APA on this basis, and claim 25 is allowable based on its dependence on claim 22.

As to Group 6: Claims 23 and 24

Claim 23 recites that in the integrated circuit of claim 22:

> said safeguard device is connected between power and ground, so that, when said safeguard device turns on, it shorts power to ground.

Claim 24 recites that in the integrated circuit of claim 22:

> said safeguard device is connected between a signal lead and ground, so that, when said safeguard device turns on, it shorts said signal lead to ground.

Claims 23 and 24 recite specifics of the connection between the safeguard device and the integrated circuit and the ramifications thereof. In particular, claim 23 recites that the safeguard device is connected between power and ground and claim 24 recites that the safeguard device is connected between a signal lead and ground. Claims 23 and 24 further recite that when the safeguard device turns on, it shorts to ground — in claim 23, power shorts to ground and in claim 24, signal shorts to ground.

Neither Kalnitsky, the APA, nor the combination of these two references, discloses or suggests a safeguard device or the specifics of its connection to an integrated circuit. Claims 23 and 24 are allowable over the combination of Kalnitsky and the APA on this basis.

Issue 6(c): Whether claims 1-2, 4-7 and 22-25 were properly rejected under 35 USC § 103(a) over U.S. Pat. No. 5,748,412 to Murdock et al. in view of APA

<u>As to Group 1: Claims 1 and 2</u>

The final clause of claim 1 recites that:

> the effective threshold voltage of said first device is more susceptible to be lowered by ionizing radiation than is the effective threshold voltage of said second device.

The Examiner asserts that while Murdock et al. does not teach the claimed electrical connection, this is again shown by the APA.

Furthermore, the Examiner alleges that:

> Murdock teaches soft diodes having lower threshold voltage. *Therefore,* the threshold voltage of the soft diodes of Murdock is more susceptible to be lowered by ionizing radiation than a non-soft diode. *Thus*, Murdock teach the effective threshold voltage of the first device is more susceptible to be lowered by ionizing radiation than is the effective threshold voltage of the second device, as claimed. (O.A. of 4.19.02 at p. 8, ¶7, emphasis added)

The use of the words "therefore" and "thus" in the excerpt suggests that the conclusions that follow these words flow from the propositions that proceed them. But they don't.

The Examiner alleges that Murdock et al. "teaches soft diodes having lower threshold voltage." From this, the Examiner concludes that "the threshold voltage of the soft diodes of Murdock is more susceptible to be lowered by ionizing radiation than a non-soft diode." There is no support in Murock et al. for this statement.

The term "soft diode," as used by Murdock et al., <u>has nothing to do with a diode's response to ionizing radiation.</u> It's simply the term used by Murdock et al. to identify a diode that might "conduct at less than the operating voltage, V_o, of magnetoresistive sensor element 34." (Col. 10, lines 26-29.) There is no basis whatsoever for the Examiner's assertion that "the threshold voltage of the soft diodes of Murdock is more susceptible to be lowered by ionizing radiation than a non-soft diode." The Examiner has taken the term "soft" from "soft diode" out of context and

has provided his own definition for the term — which is at odds with the way that term is defined in Murdock et al.

Furthermore, the first and second devices that are recited in claim 1 are electrically coupled to one another. There is no indication in Murdock et al. that the soft diodes are electrically connected to non-soft diodes. The soft diodes are electrically coupled to the magnetoresisitve sensor. So, even though the Examiner's allegations concerning "soft diodes" are inapposite to applicant's claims, the comparison should be between soft diodes and magnetoresistive sensors, not soft diodes and non-soft diodes. In any case, there is no indication in Murdock et al. that "soft" diodes have an effective threshold voltage that is more susceptible to be lowered by ionizing radiation than is the effective threshold voltage of a magnetoresistive sensor or of a non-soft diode.

Furthermore, the term "device," as recited in claim 1, has been defined in the specification to mean "transistor and the surrounding materials that affect its operating parameters." The Murdock et al. soft diodes are not a first "device," nor is the magnetoresistive sensor as second "device," as the term "device" is used by applicants. The Examiner cannot ignore applicants' definition.

Since neither Murdock et al., the APA, nor the combination thereof disclose or otherwise suggest:

- a first device (transistor) and a second device (transistor) that are electrically connected in the claimed manner; and
- that the effective threshold voltage of said first device is more susceptible to be lowered by ionizing radiation than is the effective threshold voltage of said second device;

claim 1, and claim 2 dependent thereon, are allowable thereover.

As to Group 3: Claims 4 and 5

Claim 4 recites that the integrated circuit of claim 1 comprises:

a microprocessor that comprises a control sequencer coupled to an arithmetic logic unit.

Claim 5 recites that the integrated circuit of claim 1 comprises:

an arrangement of memory cells operatively connected to an address decoder.

There is no discussion or suggestion in Murdock et al., the APA or the combination thereof to incorporate either a control sequencer coupled to an arithmetic logic unit, or

an arrangement of memory cells operatively connected to an address decoder into an IC that includes electrically-connected transistors having different radiation sensitivity. Claims 4 and 5 are therefore allowable over Murdock et al. and the APA.

<u>As to Group 4: Claims 6 and 7</u>

Claim 6 recites that in the integrated circuit of claim 1:

> said second lead of said first device is connected to ground,
> said first lead of said first device is connected to power, and
> said first lead of said second device is connected to power.

Claim 7 recites that in the integrated circuit of claim 1:

> said first device shorts power to ground when said device has been exposed to ionizing radiation.

Claims 6 and 7 describe the nature of the connection between the first device (*e.g.*, the safeguard device) and the second device (*e.g.*, the utile device). More particularly, the devices are connected so that the first device shorts power to ground when the first device has been exposed to ionizing radiation.

Neither Murdock et al., the APA, nor the combination thereof discloses or suggests that two devices having different radiation susceptibility should be connected in the claimed manner. Claims 6 and 7 are allowable over the combination of Murdock et al. and the APA on this basis.

<u>As to Group 5: Claims 22 and 25</u>

Claim 22 recites an integrated circuit comprising:

> a safeguard device comprising a first lead, a second lead, and a third lead, wherein said third lead of said first device is electrically connected to ground; and
> a utile device comprising a first lead, a second lead, and a third lead, wherein said third lead of said second device is electrically connected to ground, and wherein said first lead of said second device is electrically connected to said first lead of said first device;
> wherein upon exposure to a sufficient amount of ionizing radiation, said safeguard device turns on before said utile device, and affects operation of said utile device.

Neither Murdock et al., the APA, nor the combination thereof, disclose or suggest incorporating, into an integrated circuit, a safeguard device "that is designed to interrupt the functioning of all or part of an integrated circuit when the integrated circuit is exposed to ionizing radiation." In fact, as previously discussed, Murdock et al. teaches protecting, rather than disabling circuitry (*i.e.*, protecting the magnetoresistive sensor element 34) on occurrence of static discharge.

Nor is there any indication that Murdock's soft diodes turn on before the magnetoresistive sensor upon exposure to a sufficient amount of ionizing radiation. In other words, a soft diode's proclivity to conduct at a lower voltage than the magnetoresistive sensor says nothing about it's behavior, relative to the magnetoresistive sensor, on exposure to ionizing radiation.

There is nothing about the combination of Murdock et al. and the APA that would lead one skilled in the art to the invention defined by claim 22. Claim 22 is allowable over the combination of Murdock et al. and the APA on this basis, and claim 25 is allowable based on its dependence on claim 22.

As to Group 6: Claims 23 and 24

Claim 23 recites that in the integrated circuit of claim 22:

> said safeguard device is connected between power and ground, so that, when said safeguard device turns on, it shorts power to ground.

Claim 24 recites that in the integrated circuit of claim 22:

> said safeguard device is connected between a signal lead and ground, so that, when said safeguard device turns on, it shorts said signal lead to ground.

Claims 23 and 24 recite specifics of the connection between the safeguard device and the integrated circuit and the ramifications thereof. In particular, claim 23 recites that the safeguard device is connected between power and ground and claim 24 recites that the safeguard device is connected between a signal lead and ground. Claims 23 and 24 further recite that when the safeguard device turns on, it shorts to ground — in claim 23, power shorts to ground and in claim 24, signal shorts to ground.

Neither Murdock, the APA, nor the combination thereof discloses or suggests a safeguard device or the specifics of its connection to an integrated circuit. Claims 23 and 24 are allowable over the combination of Murdock and the APA on this basis.

Issue 6d: Whether claim 3 was properly rejected under 35 USC § 103(a) over Kalnitsky and APA as applied to claim 1, and further in view of U.S. Pat. No. 5,294,843 to Tursky et al.

Claim 3 recites that in the integrated circuit of claim 1:

> said first device comprises a field oxide that has been implanted with a material that traps positive charge when said first device is exposed to ionizing radiation and said second device has not been implanted with said material.

The Examiner alleges that Tursky et al.:

> teach forming a first device with a *field oxide* that has been implanted with a material that *traps positive charge* when the first device is exposed to *ionizing radiation* and the second device has not been implanted with the material. It would have been obvious to a person of ordinary skill in the art at the time the invention was made to form a first device with a field oxide that has been implanted with a material that traps positive charge in [the] prior art's device, in order to obtain a soft diode with a well know alternative method. (Action dated 04.09.02 at p. 6, ¶4, emphasis added.)

Tursky et al.do NOT teach:

- implanting into transistors; or
- implanting into the field oxide of transistors; or
- implanting into the field oxide of diodes, or
- implanting with a material that traps positive charge.

Tursky et al. says nothing whatsoever about trapping positive charges. It is not understood how the Examiner can make such an assertion.

Since the combination of Kalnitsky and the APA do not obviate claim 1, and since the combination of these references with Tursky et al. do not disclose or suggest the limitations of claim 3 wherein, in the integrated circuit, the first device comprises a field oxide that has been implanted with a material that traps positive charge when said first device is exposed to ionizing radiation and said second device has not been implanted with said material, claim 3 is allowable over that art.

Issue 6e: Whether claim 3 was properly rejected under 35 USC § 103(a) over Murdock et al. and APA as applied to claim 1, and further in view of U.S. Pat. No. 5,294,843 to Tursky et al.

The analysis here is essentially the same as for Issue 6d. The combination of Murdock et al. and the APA do not obviate claim 1, and the combination of those references with Tursky et al. does not disclose or suggest the limitations of claim 3. Consequently, claim 3 is allowable over the combination of these references.

Respectfully,

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APPENDIX

(9) *Claims on Appeal*

1. (Amended) An integrated circuit comprising:

a first device comprising a first lead, a second lead, and a third lead, wherein said third lead of said first device is electrically connected to ground; and

a second device comprising a first lead, a second lead, and a third lead, wherein said third lead of said second device is electrically connected to ground, and wherein said first lead of said second device is electrically connected to said first lead of said first device;

wherein the effective threshold voltage of said first device is more susceptible to be lowered by ionizing radiation than is the effective threshold voltage of said second device.

2. The integrated circuit of claim 1 wherein said first device comprises an *n*-type metal-oxide semiconductor field-effect transistor.

3. The integrated circuit of claim 1 wherein said first device comprises a field oxide that has been implanted with a material that traps positive charge when said first device is exposed to ionizing radiation and said second device has not been implanted with said material.

4. The integrated circuit of claim 1 wherein said integrated circuit further comprises a microprocessor that comprises a control sequencer coupled to an arithmetic logic unit.

5. The integrated circuit of claim 1 wherein said integrated circuit further comprises an arrangement of memory cells operatively coupled to an address decoder.

6. (Amended) The integrated circuit of claim 1 wherein said second lead of said first device is connected to ground, said first lead of said first device is connected to power, and said first lead of said second device is connected to power.

7. The integrated circuit of claim 1 wherein said first device shorts power to ground when said device has been exposed to ionizing radiation.

22. An integrated circuit comprising:

a safeguard device comprising a first lead, a second lead, and a third lead, wherein said third lead of said first device is electrically connected to ground; and

a utile device comprising a first lead, a second lead, and a third lead, wherein said third lead of said second device is electrically connected to ground, and wherein said first lead of said second device is electrically connected to said first lead of said first device;

wherein upon exposure to a sufficient amount of ionizing radiation, said safeguard device turns on before said utile device, and affects operation of said utile device.

23. The integrated circuit of claim 22 wherein said safeguard device is connected between power and ground, so that, when said safeguard device turns on, it shorts power to ground.

24. The integrated circuit of claim 22 wherein said safeguard device is connected between a signal lead and ground, so that, when said safeguard device turns on, it shorts said signal lead to ground .

25. The integrated circuit of claim 22 said safeguard device comprises an *n*-type metal-oxide semiconductor field-effect transistor.